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ELECTRICAL FLUCTUATIONS AS A METHOD
OF ANALYSIS OF PROCESSES IN METALS

New results on electrical fluctuations have been received from Ye. Ya. Pumper, a candidate in mathematical physics at the Physics Institute imeni Lebedev, Academy of Sciences USSR.

Fluctuations in current and voltage in wires were experimentally observed about 25 years ago. The existence of such a process follows immediately from molecular-kinetic concepts of thermal motion. For this reason, electrical fluctuations in wires have received the name "thermal fluctuations" or "thermal effect." The theory of the thermal effect, developed for a system in thermodynamic equilibrium, gives the possibility of quantitatively characterizing fluctuation intensity. Measurements carried out shortly after the experimental observation of electrical fluctuations showed that the theory of the thermal effect in the first approximation is justified by experiments.

The investigation of electrical fluctuations developed considerably in the course of recent years in connection with increasing the sensitivity of radio-receiver installations, amplifiers, measuring apparatus, and various indicator devices. The problem of electrical fluctuations became an important practical problem, since electrical fluctuations at present set limits on the sensitivity of apparatus. The greatest part of the conducted works proceeds from the theory of the thermal effect, and its main problem is the search for the optimum relation between the parameters of electrical systems to obtain the most useful relation between signal and fluctuation level in an indicator.

The investigation conducted by Pumper on the nature of this phenomenon differs from these works in that the problem of the physical nature of electrical fluctuations is set up anew in his work, which nature was already considered solved by others. A more perfect measuring and amplifying apparatus, now in existence, permitted the investigator to study electrical fluctuations

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- 1 -

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in wires more accurately than in previous works. It was shown that the fluctuation level in a number of wires is higher than that given by the theory of the thermal effect. The results obtained are explained by the fact that such wires must be considered as systems in the state of thermodynamic equilibrium. This means that in these systems electrical fluctuations are due not only to thermal movements, but also to processes initiated by certain supplementary sources of energy within the wire. Experiments have shown that such energy sources, which are able to increase the fluctuation level, can be, in particular, the crystalline lattice of the wire which releases microscopic portions of energy bounded with the processes occurring in the lattice. Experimental determinations of the fluctuation level relative to the level of the thermal effect permit one to study the kinetics of microscopic processes occurring in wires.

The results obtained by Pumper afford this fundamental consideration: measurements of electrical fluctuations open up possibilities of creating an extremely sensitive method for the analysis of microscopic processes occurring in metals and alloys, which are often not at all accessible to observation by means of ordinary methods used in metallophysics or are observable only by very indirect methods; for example, the aging process in alloys, which is observed by the variation in the hardness of the alloys.

In order to realize such a method, it is necessary, of course, to conduct a great number of various investigations with the purpose of systematizing the results and connecting them with data afforded by present-day metallophysics.

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- 2 -
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